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A CERAMIC MATERIAL OF LOW THERMAL EXPANSIVITY

In volume 10 (June, 1929) and volume 11 (February, 1930) of the *Ber. der Deut. Ker. Gesell.*, W. M. Cohn presents the results of thermal expansion determinations on a ceramic body having the remarkably low coefficient of thermal expansion of 0.53×10^{-6} (106 parts per 1,000,000) in the temperature range 0° to 200° C. His results indicate a slight contraction reaching a maximum of about 10 parts per 1,000,000 at approximately 70° C., after which the material expands at a gradually increasing rate. A typical body composition was given as 43 per cent steatite, 35 per cent Zinzendorfer clay, and 22 per cent anhydrous Al_2O_3 .

To duplicate these interesting results a body was prepared of 43 per cent talc, 35 per cent kaolin from Florida, and 22 per cent corundum, and subjected to a number of different heat treatments. Not only were expansions obtained similar to those found by Cohn, but it was possible to establish the fact that the low expansivity is a characteristic of one form of the mineral cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$). The formation of this compound apparently proceeds very slowly at $1,350^{\circ}$ C. and with increasing rapidity at higher temperatures

up to approximately $1,450^{\circ}$ C. where dissociation begins. Contraction below 100° C. was noted only for certain specimens made with talc as the source of the MgO . The smallest length changes noted were those of the talc body heated for three days at $1,350^{\circ}$ C. and were as follows (given in parts per million): 60° contraction of 15 parts; 203° expansion of 63 parts; 402° expansion of 301 parts. Specimens made of reagent quality materials in the cordierite ratio, heated 20 minutes at $1,415^{\circ}$ C. and containing approximately 90 per cent of the ternary compound, showed the following expansions: 60° , 15 parts; 140° , 80 parts; 200° , 160 parts. The same specimens, if held for some hours at 950° C., apparently invert to the form described by Rankin and Merwin as unstable (*A. J. Sci.*, vol. 195, p. 45; 1918) and the thermal expansion has been increased to 415 parts per 1,000,000 at 200° C. However, reheating at $1,350^{\circ}$ to $1,400^{\circ}$ C. causes reversion to the low expanding form.

The magnesium silicates, forsterite, and clinoenstatite, undergo very large length changes when heated, the former being higher than that of corundum, and these are in turn exceeded by the expansion of a $CaO \cdot SiO_2$, which was 2,020 parts per 1,000,

000, at 200° C. The expansion of ortho zinc silicate is surprisingly low, 389 parts at 295° C., and preliminary tests of natural beryl indicate that this material may have a thermal dilation lower than that of cordierite.

ENGLISH CHINA CLAY STUDY

The total dialysable bases in milliequivalents per 100 g of clay, and the percentage of colloids, obtained by water adsorption of hydrogen-saturated samples of the clays and their extracted colloids, have been determined in a study of 13 English china clays at the Columbus branch of the bureau. Various properties of the clays were plotted against the dialysable bases or base exchange capacity of the clays. In no case could a smooth curve be drawn through all of the plotted points. However, in most cases a straight line could be drawn, representing a definite general tendency. These general tendency lines indicate that with an increase in base exchange capacity of the clay there is an increase in colloidal content, drying shrinkage, and dry transverse strength. There is also an increase in shrinkage water corresponding with the drying shrinkage, a slight increase in the water adsorption of the clay, corresponding with that of the colloid content. The dry transverse strength shows the most variation with a change in base exchange capacity, the general tendency line showing a strength of 30 lbs./in.² corresponding to 2.5 milliequivalents of dialysable bases per 100 g of clay and 115 lbs./in.² corresponding to 7.0 milliequivalents per 100 g of clay. There is no apparent relation between the base exchange capacities of the clays and the $\text{SiO}_2:\text{R}_2\text{O}_3$ ratio of their colloidal extracts.

COMPOSITION AND THERMAL EXPANSION OF SOME SODA-LIME-SILICA GLASSES

The thermal expansions of 13 soda-lime and 20 soda-lime-silica glasses were measured between room temperature and softening point by the interferometer method. The silica content of these glasses varied from about 52 to 80 per cent, the balance being either soda or soda and lime, but the lime did not exceed 16 per cent.

The relation between composition and expansion can be fairly accurately expressed by the following equations:

$$Tb_1 = 495 + 0.95B - 0.058B^2$$

$$Tb_2 = 535 - 0.045B^2$$

$$Eb_1 = 5 + 2.65B - 0.0200B^2$$

$$Eb_2 = 6 + 3.13B - 0.0275B^2$$

$$Tc_1 = 485 + 0.95(B+C) - 0.058(B+C)^2 + 216R$$

$$Tc_2 = 520 - 0.045(B+C)^2 + 233R$$

$$Ec_1 = 2.5 + 2.65B + 2.37C - 0.0200(B+C)^2$$

$$Ec_2 = 14 + 2.50B + 2.37C - 0.0200(B+C)^2$$

The "key" for these equations follows: T =temperature (°C); E =expansion (microns per centimeter); B =percentage of soda; C =percentage of lime; R =ratio of lime to the soda plus lime, $\left(\frac{C}{B+C}\right)$; b indicates soda-silica

glasses; c indicates soda-lime-silica glasses; the subscript (1) indicates critical temperature or the expansion at that temperature, and subscript (2) indicates the softening temperature or the expansion at that temperature.

From the above equations it is thought one can obtain a fairly accurate idea of the temperature at which rapid expansion of any glass of the series studied begins, the temperature at which the glass begins to soften appreciably, and also the total expansions from room temperature to these temperatures. Then, with an idea as to the general shape of thermal expansion curves for glass, one can draw a fairly good graph to represent the thermal expansion of the glass. The equations also give some indication as to the range in which such glasses could be annealed because the annealing range is usually regarded as that temperature range between the critical temperature and the initial softening point.

ULTRA-VIOLET AGRICULTURAL GLASS

In view of the inquiries received at the bureau as a result of the increased sales promotion of "Agricultural Window Glass," "Ultra-Violet Agricultural Glass," etc., for use in hen houses and other animal houses, the following information may be of interest.

The term "agricultural glass" is a misnomer that is subject to misunderstanding and open to misrepresentation of the product.

As presented to this bureau it represents a window glass made especially for transmitting ultra-violet solar rays of wave lengths 302 millimicrons and shorter. It is in reality a grade C or very poor grade B of this special glass, that contains optical

flaws which make the glass unsightly in dwellings and solariums but which has practically the same ultra-violet transparency as grades A and B.

It is well known that the ultra-violet transparency of the different melts of these special window glasses is variable. Hence it is possible for "agricultural glass" to become the dumping ground for the poorer melts of ultra-violet transmitting glass.

It is interesting to note that much of the present-day sales promotion of these special window glasses for use for healing human beings, is based upon experiments originally performed upon chicks, white rats, and other animals. Attention is therefore called to a report to the council of physical therapy of the American Medical Association (J. A. M. A., vol. 88, p. 1562; May 14, 1927) showing that a transmission of 30 per cent at 302 millimicrons is required in order to insure that the amount of ultra-violet passing through the glass will be effective. Glass that transmitted only 5 per cent at 302 millimicrons gave no protection from rickets and in this particular test even the 30 per cent transmission did not effect a 100 per cent cure of rickets.

SOUNDPROOF PARTITIONS

The acoustic laboratory of the bureau has recently made sound transmission measurements on a set of wall panels the results of which should be of general interest.

The panels were constructed of cinder block and clay tile, and were built with instructions to use workmanship such as would ordinarily be used in a construction job. A description of the panels follows:

- No. 1. Standard Straub hollow cinder block partition tile 4 by 8 by 18 inches. Weight of finished panel 29.7 lbs./ft.² Thickness of wall 4 inches.
- No. 2. New Jersey porous hollow clay partition tile 4 by 12 by 12 inches. Weight of finished panel 27.5 lbs./ft.² Thickness of wall 4 inches.
- No. 3. New Jersey hollow clay tile 4 by 12 by 12 inches with 1-inch shells. Weight of finished panel 37.5 lbs./ft.² Thickness of wall 4 inches.
- No. 4. New Jersey standard clay partition tile, 4 by 12 by 12 inches. Weight of finished panel 33.4 lbs./ft.² Thickness of wall 4 inches.

In each case the panels were laid up in a mortar composed of 1 part Port-

land cement to 1 part of lime to 5 parts of sand by volume.

The panels were plastered on both sides with a 5/8-inch coat of gypsum plaster and a white finish coat.

The results of these measurements are as follows:

Frequency band (in cycles per sec.)	Reduction factor (in decibels)			
	Panel No. 1	Panel No. 2	Panel No. 3	Panel No. 4
118 to 138.....	30	31	30	33
241 to 271.....	30	31	35	35
486 to 538.....	38	36	44	42
977 to 1,071.....	48	47	52	46
1,956 to 2,140.....	53	50	56	49
3,961 to 4,231.....	59	58	65	62
Average.....	43	42	47	44

The reduction factors are given in decibels as the results are thereby expressed in numbers which are approximately proportional to the loudness of a sound as heard by the ear. The larger the reduction factor the better the sound insulation of the panel.

One decibel is practically equivalent to the smallest change in intensity that the average ear can detect. Because of the smallness of this unit a difference of less than 5 decibels is of no practical importance. It will be noticed that the average reduction factors for the panels measured differ by not over 5 decibels. The total reduction factor of say 45 decibels should be sufficient to reduce ordinary conversation to inaudibility.

The method of making these measurements is described at length in Bureau of Standards Scientific Paper S526. In brief, the test panel was built into an opening in one wall of a room specially constructed so that the other walls were as nearly soundproof as possible. The source of sound was a loud-speaker located in this room and caused to rotate continually to break up the interference pattern. In addition a frequency band was used in each case to give a more uniform distribution of the sound energy. The center points of the bands were at 128, 256, 512, 1,024, 2,048, and 4,096 cycles per second. The intensity of the sound was measured on each side of the wall, within and without the room in which the source of sound was located, and from the difference in intensity the foregoing results were calculated.

**CONTROL OF RELATIVE HUMIDITY IN
A SMALL INCLOSED SPACE**

In response to a demand for information about maintaining constant humidity in a small space, especially in a small cabinet in which some testing of paper can be done, an article has been published giving a brief description of suitable apparatus, together with a compilation of data for the preparation of solutions having the required relative vapor pressure. Tables are given containing data for sulphuric acid solutions, glycerine solutions, and saturated solutions of certain salts. In order to obtain a certain relative humidity one of the solutions is prepared having a relative vapor pressure corresponding to the desired relative humidity, and the air to be conditioned is washed with this solution or otherwise brought to vapor pressure equilibrium with it. Since the pressure of saturated water vapor changes rapidly with temperature change, resulting in a corresponding change in relative humidity for a given vapor pressure in the air, some form of temperature control is necessary. Several procedures are available, the choice depending upon the particular laboratory conditions and the accuracy required. The measurement of the relative humidity by means of a modified form of wet and dry bulb psychrometer is briefly described.

The article was published in *Paper Trade Journal*, October 29, 1931, and reprints are available at the bureau.

DETERIORATION OF LEATHER

Vegetable-tanned leather is often bleached with sulphuric acid in order to improve its color and appearance. This step in the process often occurs before the finishing or stuffing with oils and greases which form a part of nearly every commercial leather.

A study has been completed to determine whether the addition of grease to leather retarded or accelerated its deterioration by any sulphuric acid which might be present before the grease was applied. Leather was tanned with chestnut and quebracho extracts and treated so that samples containing 0, 1, 2, 3, and 4 per cent sulphuric acid were obtained. A further division of the samples was made and these were treated so as to contain 0, 10, and 20 per cent by weight of a 50-50 mixture of cod oil and tallow.

All the samples were tested for tensile strength and then stored at 70° F. and 65 per cent relative humidity. Se-

lected samples were again tested for tensile strength after 6, 12, 18, and 24 months. The change in strength of the samples during aging was taken as a measure of their deterioration.

The results showed no significant difference in the rate and amount of deterioration occurred whether the leather contained grease or not. The addition of grease, therefore, does not appear to influence the action of the sulphuric acid which may be present in leather before the grease is applied.

**PROGRESS IN AERONAUTIC RADIO
RESEARCH**

The development of radio receiving equipment for airplanes has been advanced by recent work of the bureau. Detailed specifications have been prepared for equipment to receive beacon signals of the visual type. These are timely in view of the installation of the visual type of radio range beacons on the midcontinent airway, from Amarillo, Tex., to Los Angeles, Calif. The specifications include means for applying an automatic volume control unit to the airplane receiving sets at present in use, together with performance curves of the unit. Installations of receiving equipment as described in the specifications were made on several airplanes belonging to the Department of Commerce, serving as model installations and as means of flight testing the visual radio range beacons.

Progress has been made in the design of a set for simultaneous radiophone and range-beacon reception. The equipment hitherto available was not wholly suitable for this service, primarily because of inadequate audio-frequency characteristics and low power output. Experimental work has shown that an undistorted power output of 400 milliwatts is desirable to insure satisfactory service during conditions of severe atmospheric disturbances. Likewise it is essential that the receiving set have a uniform response for frequencies from 50 to 3,000 cycles. These sets will be equipped with automatic volume control and will operate on the transmission from the simultaneous radiophone and visual range beacon, the visual range beacon, the airways radiophone service, and the aural range beacons.

The airplane fuselage is often used as a "ground" return lead between various portions of the radio circuits, in the installation of radio equipment on airplanes. This subject has been studied. Bolted connections to the

fuselage have been known to loosen so that, during vibration, the electrical connection was of variable resistance. This resulted in noise in the receiving set output having the regularity and other characteristics of ignition interference. In other cases, the fuselage, although a completely welded type, offered a resistance to the flow of current equivalent to that of a direct wire connection of No. 14 A. W. G. The drop in battery voltage would depend upon the number of radio units in operation. Turning one set off or on would, therefore, affect the operation of whatever other radio unit was being used. The cure for difficulties of these types is to provide a direct copper connection for ground return leads, particularly where such leads carry considerable current.

An improved method for calibrating the reed indicators used with the visual radio beacon system has been developed. Hitherto, each reed has been tuned as closely as possible to the frequency desired and its resonance curve adjusted so that the sharpness of resonance was equal to a predetermined value. An over-all test has now been added whereby equal voltages of both reed frequencies are applied to the reed indicator (so that an "on-course" indication is obtained) and the two frequencies are simultaneously varied from minus to plus one-half per cent of their proper values. Any change from the on-course indication will then show that the resonance curves of the two reeds do not have the proper relation. The addition of this over-all test increases the accuracy of adjustment of the reed indicator under calibration, and reduces the amount of care needed in tuning the reeds.

Some simplifications have been made in the design of the aircraft direction finder. The input switching unit has been arranged so that only one loop antenna is required, in place of the crossed loop antenna system previously employed. Besides the reduction in the number of loop antennas, there is additional simplification in the condenser arrangement of the input unit. The direction of deviation from the indicated course is given the pilot by means of a zero-center pointer type course indicator. The use of the direction finder for taking cross bearings is at the same time made considerably easier through the elimination of the right-angle courses which were present with the crossed-loop antenna system.

RADIO TRANSMISSIONS OF STANDARD FREQUENCY, JANUARY, FEBRUARY, AND MARCH, 1932

The bureau announces a new schedule of radio transmissions of standard frequency at 5,000 kilocycles. This service may be used by transmitting stations in adjusting their transmitters to exact frequency, and by the public in calibrating frequency standards and transmitting and receiving apparatus. The signals are transmitted from the bureau's station WWV, in a suburb east of Washington, D. C., every Tuesday afternoon and evening. They can be heard and utilized by stations equipped for continuous-wave reception throughout the United States, although not with certainty in some places. The accuracy of the frequency is at all times better than 1 part in 1,000,000.

The transmissions are by continuous-wave telegraphy. They are given continuously from 2 to 4 p. m., and from 8 to 10 p. m., eastern standard time, every Tuesday. The dates are January 5, 12, 19, 26; February 2, 9, 16, 23; and March 1, 8, 15, 22, 29.

The transmissions consist mainly of continuous, unkeyed carrier frequency, giving a continuous whistle in the phones when received with an oscillatory receiving set. The first five minutes of the transmission consist of the general call (CQ de WWV) and announcement of the frequency. The frequency and the call letters of the station (WWV) are given every 10 minutes thereafter.

Information on how to receive and utilize the signals may be obtained on request to the bureau. From the 5,000 kilocycles any apparatus may be given as complete a frequency calibration as desired by the method of harmonics.

The bureau is desirous of receiving reports on these transmissions, especially because radio transmission phenomena change with the season of the year. The data desired are approximate field intensity, fading, and the suitability of the transmissions for frequency measurements. It is suggested that in reporting upon field intensities for these transmissions, the following designations be used where field intensity measurement apparatus is not at hand: (1) Hardly perceptible, unreadable; (2) weak, readable now and then; (3) fairly good, readable with difficulty; (4) good, readable; (5) very good, perfectly readable. A statement as to whether fading is present or not is desired, and

if so, its characteristics, such as whether slow or rapid and time between peaks of signal intensity. Statements as to type of receiving set used in reporting on the transmissions and the type of antenna used are likewise desired. The bureau would also appreciate reports on the use of the transmissions for purposes of frequency measurement or control.

All reports and letters regarding the transmissions should be addressed "Bureau of Standards, Washington, D. C."

**ANNUAL REPORT OF THE DIRECTOR OF
THE BUREAU OF STANDARDS FOR
THE FISCAL YEAR ENDED JUNE 30,
1931**

One of the most interesting facts brought out in the Director's Annual Report for 1931, which was released on November 17, is that business conditions up to the close of the fiscal year brought no reduction in requests for the bureau's services. Thus, the number of research associates stationed at the bureau by industrial groups did not change materially. On June 30, 1931, there were 95 associates representing 44 groups as compared to 96 and 41 last year. Many lines of testing, notably building materials, thermometers, and radium show large increases. Conferences, including the National conference on Weights and Measures, the conference of State utility commission engineers, and the meeting of chairmen of simplified practice committees were well attended.

The year was particularly satisfactory in the matter of international cooperation. The bureau maintained its close relations with the national laboratories abroad and progress was made in the standardization of electrical, temperature, and photometric measurements, industrial length measurements, and X rays. An exchange arrangement was carried out between the bureau and the Physikalische Technische Reichsanstalt by which Dr. F. Henning was sent to Washington for two months' work on the new absolute standard of light and on temperature measurements, while G. W. Vinal went to Berlin to assist in comparisons of the electrical standards. The International Committee on Weights and Measures agreed upon a temperature of 68°F. as an international standard for all industrial length-measuring instruments; a most important step in the standardization of shop procedure.

The physical plant of the bureau received some important additions.

The alterations to the north building were completed, and work was started on the new national hydraulic laboratory. Eleven acres of additional land were purchased to complete the bureau's site. Locations at Beltsville and Meadows, Md., were decided upon for the two new radio research laboratories authorized at the last session of Congress. At Beltsville the station is to be located on land set aside through the courtesy of the Department of Agriculture. Negotiations were commenced for the purchase of the necessary land at Meadows.

Recalibration of the bureau's steel bench used in testing surveyor's tapes showed that this had changed but little during the 26 years it had been in service and proved that results of tests based on comparisons with this standard are of a high order of accuracy. A master clock for signals of very high accuracy, and using a free pendulum and a photo-electric cell was designed and built, and preliminary experiments with it, as installed in the clock vault, were completed.

Measurements at 100,000 volts with the new absolute electrometer, designed and built at the bureau, showed good agreement with results using a voltage transformer and electrodynamic voltmeter.

Improvements were made in radio-frequency standards. A new series of standard frequency transmissions, accurate to better than 1 part in 1,000,000, was inaugurated last January. Regular measurements were made of the height of the Kennelly-Heaviside layer, and are being published by Science Service.

The standardization of Lovibond glasses for color-grading of commodities was continued, and 1,696 have now been accepted. Under an arrangement with the American Railway Association the bureau was made the custodian of the standard color glasses for railroad signals.

Standards were established for the light fastness of dyed textiles based upon the amount of fading which takes place under definite conditions of exposure. Standard sizes were agreed upon for knit underwear. These were set up through the cooperation of all interested groups, and will be published as a commercial standard.

Methods of controlling dimensional changes in electrotypes were studied, as well as causes of changes in the paper, to aid the color-printing industry. The importance of using highly purified fibers in the manufac-

ture of paper for permanent records was an important result of a cooperative research on this subject. The effects of sulphuric acid, present in the atmosphere of large cities, on books and documents in libraries was shown to be one of the principal causes of their rapid deterioration. In the case of leather, that tanned with quebracho-wood extract was found more resistant to the deteriorating effect of sulphuric acid than chestnut-tanned leather.

A special cotton cloth, which in an emergency can be substituted for silk in making parachutes, was developed in cooperation with the National Advisory Committee for Aeronautics, and passed the military tests.

In studying the strength of airship girders it was found that in some cases resistance to torsion in the members was the limiting factor. By restraining these parts so that they could not twist, over 40 per cent was added to the strength of the girder. This should permit lighter and stronger construction.

Mufflers and crash-resistant tanks for airplanes were investigated, and a special flexible lining material for the interior of tanks gives some promise of success.

A total of 27 new commercial airplane engines was tested for the Aeronautics Branch of the Department of Commerce in the bureau's special plant at Arlington, Va. Of these, 14 passed the test, 11 failed, and 2 were withdrawn.

Improvements in radio aids to air navigation included the development of a new pointer type reed indicator and improvements in details of the blind-landing system.

A study of vapor lock showed that many automobile fuel systems are poorly designed and are likely to give trouble in hot weather because of boiling of the gasoline. On the basis of the bureau's findings, considerable improvements will probably be incorporated in the 1932 cars.

The standard brake code for motor vehicles was revised to bring it up to date with the almost universal use of 4-wheel brakes.

One of the most unusual laboratories ever constructed at the bureau was completed late in the year. It is a square wooden tower 100 feet high with a water tank on top and is being used to study the flow of water in plumbing systems as used in tall buildings.

In the field of building and housing a survey was made of the problems of

5,000 purchasers of homes, to supplement previous work on home-financing methods, and the results will form the basis of a report. A book entitled "Care and Repair of the House" was issued, and has been in great demand.

The report records studies of practically all the common building materials, such as brick, cement, concrete, lime, gypsum, terra cotta, slate, stone, and special combinations of these. The volume of cement sample (2,311,000 barrels) is the highest on record, being 42 per cent larger than in 1930. This increase is to be attributed in the main to the Government's enlarged building program. The cement reference laboratory, maintained jointly by the bureau and the American Society for Testing Materials, conducted inspections in 122 cement testing laboratories, and many requests for similar service were on hand at the close of the year.

Fire tests of building materials included special fire-retardant wood partitions and a new type of steel floor construction. The bureau cooperated with the Federal Fire Council and the National Fire Protection Association on fire prevention in Government buildings and on the preservation of records. Assistance was given the government of the District of Columbia in the revision of its code for gas fittings.

A report was prepared on the results of an inspection of 1,000 specimens of ferrous pipe materials buried in various soils. Results from 2,000 specimens of nonferrous materials showed that, in general, alloys containing copper resist the action of most soils very well.

A method was developed for measuring the fluidity of metals in casting, and should prove of great value to foundries in controlling the quality of their products.

An optical depth gage was constructed, which operates on somewhat the same principle as a range finder, by which it is possible to measure inaccessible dimensions in the line of sight.

Secondary brittleness in rails, which sometimes results in transverse fissures, was shown to be much reduced by retarding the cooling after rolling. The "creep" characteristics of alloy steels under load and when heated were determined and should aid in the design of boilers, oil stills, etc., which operate at high pressures and temperatures.

The number of railroad track scales tested, 1,030, is larger than in any pre-

vious year, and the percentage of correct scales shows a small but significant increase.

Street-car efficiency may be increased and noise reduced as the result of a study of gearing and other parts of the driving mechanism, which was conducted in cooperation with the American Electric Railway Association.

A report was prepared outlining the manufacturing procedure necessary in the production of chinaware resistant to cutlery marking.

Thirty pots of optical glass were made in the experimental glass plant. From this glass 88,000 lens and prism blanks were furnished to the optical shop of the Navy Department.

A new process, which may prove of great commercial importance, was worked out for manufacturing sugar acids and their salts, and portions of the semicommercial plant for the production of levulose, were operated with success. Insulating board from cornstalks is now an accepted commercial fact, but laboratory experiments were continued to improve the production method and to render the board more resistant to fire and water. An investigation of the use of the sweetpotato as a source of starch in the southern textile industries was commenced in cooperation with the Alabama Polytechnical Institute. The University of Alabama is also cooperating with the bureau in a study of the manufacture of Kraft paper from southern woods.

Many improvements in dental materials resulted from the bureau's co-operative studies with the American Dental Association, only 10 per cent of the material submitted by manufacturers for use of the Government being found below the specifications.

One of the most interesting services rendered by the bureau was in its development of standards for identification of questioned documents. Several cases to which the Government was a party were brought to a successful conclusion on the basis of evidence submitted by the bureau. A single case resulted in a saving of over \$150,000 to the Treasury Department.

The use of specifications by private purchasers was facilitated by the preparation of lists of willing-to-certify manufacturers and by giving every encouragement to the use of quality-guaranteeing labels.

Twenty new simplified practice recommendations were developed, covering a wide variety of commodities. The total number of recommen-

dations at the close of the year was 149 and the average adherence of the manufacturers report, was about 90 per cent, as compared with 87 last year. Sixty-two commercial standards projects were active, 12 having been printed during the year.

A new handbook covering safety rules for X rays was published, and the new portable X-ray standard was greatly improved.

The number of tests completed was 212,717 with a fee value of \$816,979, as compared with 200,726 and \$683,614 last year.

In conclusion, the report recommends the adoption of a uniform patent policy by the Government, covering patents on inventions made by Government employees in line of duty, the bureau having always held that such inventions belong to the public. An urgent need of the bureau is a new administration building to house the nonlaboratory activities and to relieve congestion in other buildings. Additional equipment in the branch laboratories, and particularly that at San Francisco, may also be needed in the near future to care for testing on the Pacific coast.

NEW AND REVISED PUBLICATIONS ISSUED DURING NOVEMBER, 1931

*Journal of Research*¹

Bureau of Standards Journal of Research, vol. 7, No. 5, November, 1931. (RP Nos. 372 to 386, inclusive). Price, 40 cents. Obtainable by subscription.

*Research Papers*¹

(Reprints from Journal of Research)

RP348. The resistance to wear of carbon steels; S. J. Rosenberg. Price, 10 cents.

RP349. Permanence studies of current commercial book papers; J. O. Burton. Price, 5 cents.

RP350. Thermomagnetic investigation of tempering of quenched 0.75 per cent carbon steel; G. A. Ellinger. Price, 10 cents.

¹ Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to TECHNICAL NEWS BULLETIN, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to JOURNAL OF RESEARCH, \$2.75 per year; other countries, \$3.50. Subscription to COMMERCIAL STANDARDS MONTHLY, \$1 per year; other countries, \$1.25.

- RP351. Hyperfine structures in the first spectra of krypton and xenon; C. J. Humphreys. Price, 5 cents.
- RP352. Accelerated aging test for paper; R. H. Rasch. Price, 10 cents.
- RP353. Cryoscopic constant, heat of fusion, and heat capacity of camphor; M. Frandsen. Price, 5 cents.
- RP354. The passage of gas through the walls of pyrometer protection tubes at high temperatures; W. F. Roeser. Price, 5 cents.
- RP355. An experimental study of several methods of representing photographic sensitivity; R. Davis and G. K. Neeland. Price, 10 cents.
- RP356. Some experimental studies of the vibrations of quartz plates; R. B. Wright and D. M. Stuart. Price, 20 cents.
- RP358. Optical rotation and atomic dimension — halogeno-tetra-acetyl-derivatives of mannose. Their configurational peculiarities; D. H. Brauns. Price, 10 cents.
- RP359. Soil-corrosion studies. Non-ferrous metals and alloys, metallic coatings and specially prepared ferrous pipes removed in 1930; K. H. Logan. Price, 10 cents.
- RP360. Isolation and determination of the cyclohexane in a midcontinent petroleum; J. H. Bruun and M. M. Hicks-Bruun. Price, 5 cents.
- RP361. Relation between the twist and certain properties of rayon yarns; H. A. Hamm and R. S. Cleveland. Price, 5 cents.
- RP362. The hydrolysis of chestnut and quebracho tanned leathers by sulphuric acid; E. L. Wallace. Price, 5 cents.
- RP363. Correlation of certain soil characteristics with pipe line corrosion; I. A. Denison. Price, 5 cents.
- RP364. Further description and analysis of the first spectrum of krypton; W. F. Meggers, T. L. de Bruin, and C. J. Humphreys. Price, 10 cents.
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- M128. A survey of storage conditions in libraries relative to the preservation of records; A. E. Kimberly and J. F. G. Hicks, jr. Price, 5 cents.
- M131. Annual report of director of the Bureau of Standards to the Secretary of Commerce for the fiscal year ended June 30, 1931. Price, 15 cents.

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¹ Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to TECHNICAL NEWS BULLETIN, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscriptions to JOURNAL OF RESEARCH, \$2.75 per year; other countries, \$3.50. Subscription to COMMERCIAL STANDARDS MONTHLY, \$1 per year; other countries, \$1.25.

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